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J. Billingsley

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PROVISIONAL SPECIFICATION

Invention Title: "SYNERGISTIC CO-LOCATION OF PROCESS PLANTS"

The invention is described in the following statement:

TITLE

"SYNERGISTIC CO-LOCATION OF PROCESS PLANTS"

BACKGROUND OF THE INVENTION

(1) FIELD OF THE INVENTION

THIS INVENTION relates to the synergistic co-location of process plants.

The invention is particularly suitable for, but not limited to, use of a cane sugar mill as the location of another, additional agroindustrial process plant (hereinafter referred to as "the feed mill") to process agricultural crop(s) other than sugar cane.

In particular, the feed mill may be used to process legume fodder crop(s) such as lucerne (known as alfalfa in the USA) which are grown as a fallow crop in the sugar cane farming cycle.

Throughout the specification the term "legume fodder crops" shall include lucerne (US alfalfa), lablab bean, cowpeas, and the like. Such crops have relatively high content of vegetable proteins, and are therefore valuable as animal feed ingredients if able to be processed, stored and presented in suitably digestible and nutritive format.

(2) PRIOR ART

Cane sugar mills require very large capital investment, which can only be recovered during the relatively short cane crushing season(s), which may total 5 to 7 months per year.

Similarly, the associated transport infrastructure, which, in the case of cane railway systems, is also a very significant capital investment, is

only used for half of the year.

Legume fodder crops have been grown for many years as a source of stockfeeds, but full nutritive benefits of such stockfeeds have not been possible due to losses arising in conventional harvesting and processing methods.

The Agricultural Utilization Research Institute (AURI) (USA) notes the following with regard to Alfalfa Production:

"Alfalfa has been grown as a source of animal feed for many years. Methods for producing and harvesting the crop for hay have greatly improved over time, however, one of the major problems associated with alfalfa hay production requires the crop be dried in the field and subjected to weather related yield and quality losses.

Alfalfa provides many agronomic and environmental benefits to agriculture. Alfalfa;

1. is an alternative, high value crop;
2. increases soil structure;
3. increased soil organic matter; and
4. provides a perennial legume into the rotation to help break disease and insect cycles.

Despite the advantages, alfalfa acreage and production has decreased by 10% and 13%, respectively, from 1986 to 1997. The decreased production has occurred while the price of alfalfa has increased over 30%. Some of the reasons why production levels have decreased during this time including the following:

1. Limited means to control quality;
   - The crop is subject to yield and quality losses while drying in the field;
   - Mechanical losses during crop collection [i.e., after drying in the field];
   - Many alfalfa processing plants have been lost with plant inefficiency [i.e., energy inefficient because of high fuel costs for drying], the inability to supply high quality product and the lack of focus on the customer's needs; and
   - Blending facilities are not available to guarantee product formulation.
2. Harvesting is difficult to schedule; and
3. There is no well established system to market the product."

SUMMARY OF THE INVENTION

It is an object of the present invention to use a cane sugar mill as the location of another, additional feed mill to process crop(s) other than sugar cane.

It is a preferred object to provide the feed mill to process legume fodder crop(s) such as lucerne/alfalfa or the like which may be grown as fallow crops on sugar cane farms.

It is a still further preferred object to use the existing sugar cane transport system/infrastructure, e.g., the cane railway system, to transport

the legume fodder crop.

It is a still further preferred object to co-ordinate, schedule and integrate the harvesting and transport of the legume fodder crop with the sugar cane harvesting and transport to minimise delay between harvesting and processing in order to maximise the nutrient value of the processed crop.

It is a still further preferred object to use the waste heat and excess power produced by the sugar mill from the combustion of its by-product bagasse to process the fodder crop most economically.

It is a still further preferred object to arrange the sugar mill process so that sufficient excess by-product bagasse is made available for storage and use as fuel for processing the fodder crop during those months of the year when the sugar mill is not in use processing sugar cane, in order that the amount of fodder crop to be processed may be maximised.

It is a further preferred object to provide such a feed mill which can process both coarse and fine dry fibre and which can mix the fibre with extracted juice concentrate, molasses and the like.

It is a still further preferred object to provide a feed mill which can effect pressure compaction, cubing, extrusion, moulding, tableting, granulation, agglomeration, briquetteing, baling, bagging and other like processing of the resultant feed.

Other preferred objects will become apparent from the following description.

In one aspect the present invention resides a method of

processing a fodder crop, including the steps of

(a) delivering with minimum delay, freshly harvested crop to the feed mill located at/adjacent a cane sugar mill;

(b) processing the crop to seek optimised cell breakage and/or fiberisation (i.e., separation of fibre particles) in the resultant shredded material, depending on final product specifications as required; and

(c) drying the shredded material using heat supplied by the cane sugar mill or from by-products of the cane sugar mill.

Preferably, the method includes the further step:

(d) mixing the dried material with suitable liquid binder(s) to produce a feed meal material of suitable moisture content if required for use.

Preferably, in step (a), the freshly harvested crop is delivered to the feed mill in bulk using the transport system/infrastructure of the cane sugar mill.

Preferably, in step (b), the harvested crop is shredded using heavy duty shredder/hammermill machines.

Preferably, the jute is extracted, concentrated, and stored in liquid concentrate tank(s).

Preferably, in step (c), the shredded matter is dried using hot flues gas from the sugar mill boiler, or from a separate furnace fired with sugar cane bagasse either fresh from the cane sugar mill or from a stockpile.

The dried shredded material may be separated into coarse (e.g., stem) and fine (e.g. leaf) dry fibre fractions, which may be selectively recombined during later processing.

Preferably, in step (d), the liquid binder(s) include molasses, juice concentrate and other suitable liquids to achieve the desired moisture content.

During, or after, step (d) other ingredients and additives such as vitamins, minerals, digestion improvers, antibiotics, other pharmaceuticals and the like may be added to increase the value of the feed meal material.

After step (d), the feed meal material may undergo further processing such as pelletising, crumbling, granulation, agglomeration, pressure compaction, cubing, extrusion, moulding, tableting, briquetting, baling, bagging or the like to suit the market requirements.

In a second aspect, the present invention resides in a method of processing a fodder crop including the steps of:

(a) delivering with minimum delay, freshly harvested crop to the feed mill located at/adjacent a cane sugar mill;

(b) processing the crop to produce cut and/or shredded material; and

(c) drying the cut and/or shredded material using heat supplied by the cane sugar mill or from by-products of the cane sugar mill.

Preferably, the method includes the further step:

(d) baling the dried cut and/or shredded material (or hay).

Preferably in step (b), the crop is processed using rotary knives to cut and/or shred the fibrous material.

Preferably, after step (d), the baled material (or hay) is outloaded or containerised for transport.

Preferably, at step (d), molasses may be mixed with the dried material (or hay) to increase the nutritional value thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

To enable the invention to be fully understood, preferred embodiments will now be described with reference to the accompanying drawings, in which:

Figure. 1 shows a systems diagram for the operation of the invention during the sugar cane crushing season;

Figure. 2 is a similar systems diagram for the sugar cane non-crushing season;

Figure 3 is a feed mill system diagram for the feed meal shredder and optional juice extraction and concentration plant subsystems;

Figure 4 is a feed mill system diagram for the drying plant and optional size separation and degritting plant subsystem;

Figure 5 is a feed mill system diagram for continuous mixing and optional batch mixing plant subsystem;

Figure 6 is a feed mill system diagram for the pellet mill subsystems;

Figure 7 is a feed mill system diagram for the outloading and bagging plant subsystem;

Figure 8 is a systems diagram (similar to Figures 1 and 2) for the operation of the invention with a separate hot gas generating furnace; and

Figure 9 is a systems diagram (similar to Figure 8) for the

production of a baled hay product.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to Figure 1, freshly harvested legume fodder crop e.g. lucerne/alfalfa, is transported to the feed mill 10 (to be hereinafter described in more detail), co-located with a cane sugar mill 20, on full trucks 21 of a common existing cane railway or road transport system 22, the empty trucks 23 being dispatched to be reloaded with the fodder crop.

The operation of the cane sugar mill 20 during the sugar cane crushing season is illustrated schematically in Figure 1 and incorporates a sugar mill process unit 24. Molasses produced from the sugar cane is directed to a storage tank 25 and/or the feed mill 10; while bagasse is directed to a stockpile 26, from which it is drawn off to fire a boiler 27 which provides high pressure (H.P.) steam for the powerhouse 28 to generate electricity, which can be employed to operate the feed mill 10. Hot dry flue gas 29 from the boiler 27 and/or the furnace 27a is used to dry the shredded crop.

In the non-crushing season, schematically illustrated in Figure 2, molasses can be drawn from the storage tank 25 to be mixed with the shredded fibre; and bagasse can be drawn from the bagasse stockpile 26 to fire the boiler 27 (under reduced steaming) or a furnace with no steam, the hot dry flue gas 29 from the boiler 27 and/or the furnace 27a being used to dry the shredded crop.

Where the boiler 27 supplies high pressure (H.P.) steam to the power house 28, the sugar mill evaporators in the process unit 24 can be

used as condensers to condense the exhaust or low pressure (L.P.) steam from the power house 28.

The general process steps followed in the feed mill 10 are schematically illustrated in Figures 1 and 2 (and will be described in more detail with reference to Figures 3 to 7).

The feed mill 10 receives the fresh harvested legume fodder crop, which is passed through shredders/hammermill machines in the shredder 11. After shredding, the juice may be extracted and concentrated, to be described with reference to Figure 3.

Wet shredded fodder is fed to the drying plant 12, to be dried by the hot dry flue gas 29 (as shown in Figure 1), and the wet gas may be vented to atmosphere. The dried shredded material may be sized and oversized fibre material may be reprocessed, as described with reference to Figure 4.

The dry shredded fodder is fed to a mixing plant 13 (as shown in Figure 1) and may be mixed with molasses and/or juice concentrate and/or other liquids to produce a fodder meal material of suitable moisture content.

As hereinbefore described, other ingredients and additives (eg. vitamins, minerals, antibiotics) may be added to the shredded fodder in the mixing plant 13.

In the embodiment shown in Figures 1 and 2, the feed meal material is fed to a pellet mill plant 14 to be pelletised, and then the pellets are conveyed to a bulk outloading/bagging plant 15 for supply to customers.

It will be readily apparent to the skilled addressee that the pellet

mill plant 14 and bulk outloading/bagging plant 15 can be replaced by other suitable processing/dispatch plants to suit the particular intended application/use of the feed products.

The power house 28 can supply power to operate the shredder 11/drying plant 12/mixing plant 13/pellet mill plant 14/bulk outloading/bagging plant 15.

As shown in more detail in Figure 3, the freshly harvested fodder crop is emptied from the full trucks 21 via a tipper 16 and the fresh fodder is conveyed via a fodder elevator 17 to the shredder 11.

From the shredder 11, the wet shredded fodder is transferred to a counter-current juice dilution/extraction plant 18. Diluted juice is directed to a low temperature juice concentration plant 19, and concentrated juice 47 can be fed to the mixing plant 13.

Water from the low temperature juice concentration plant 19 is recycled to the counter-current juice dilution/extraction plant 18, with excess water being sent to a drain 30.

The fibre, after extraction of the juice, is fed to a vibrating screen 31 and oversize fibre is separated and conveyed back to the fodder elevator for further processing in the shredder 11.

Undersize fibre is transferred to the drying plant 12.

As shown in Figure 4, the undersize wet fibre is dried by the hot dry flue gas 29 via a flash drying system in the drying plant 12. The dried fibre is fed to a gas/solids separator 32 and the wet gas is drawn off by a fan 33 and vented to atmosphere.

The dried fibre may be directed to an optional size separation subsystem 34, where a particle size separation device 35 separates the fibre into coarse dry fibre 36 (e.g. stems) and fine dry fibre 37 (e.g. leaf).

The coarse dry fibre 36 may be subjected to an optional degritting subsystem 38, where a vibrating screen 39 separates grit 40 (suitable for recycling to farms via mill mud) from the coarse dry fibre 36.

In the mixing plant 12, shown in more detail in Figure 5, coarse dry fibre 36 via a proportioning diverter 41; fine dry fibre 37, via a proportioning diverter 42; molasses 43 (supplied from the mill tank 25 or processing unit 24), stored in a heated molasses tank 44, with pump 45; and/or juice concentrate 47, stored in concentrate tank 48, with pump 49; are selectively fed to a continuous coarse feed mixer 50 and continuous fine feed mixer 51, to produce respective coarse and fine feed meal 52,53 received in respective coarse and fine feed meal holding bins 53a,54.

Other ingredients (e.g. vitamins, other feedstuff nutrients) are held in other ingredients holding bins 55 and are supplied to respective batch mixers 56,57 for mixing with the coarse and fine feed meals 52,53 and thereby supply to the respective coarse and fine batch holding bins 58,59. (The coarse and fine feed meals 52,53 may bypass the batch mixers 56,57.) The coarse and fine batch holding bins 58,59 supply the pellet mill plant 14.

As shown in Figure 6, the coarse feed meal/mix from the coarse batch holding bin 58 is fed to a pellet mill 14a to be pelletised, and then to a cooler 60. The cooled pellets may bypass the crumbler 61, and are fed to a vibrating screen 62, where undersize pellet particles and dust are

returned to the incoming coarse feed meal/mix for reprocessing.

The coarse feed product can be directed to bagging operations 63 and/or bulk outloading bins 64, as shown in Figure 7.

The fine feed meal/mix follows a similar path through pellet mill 14b, cooler 60a, crumbler 61a, vibrating screen 62a, bagging operations 63a, and bulk outloading bins 64a.

It will be readily apparent to the skilled addressee that the processing steps, other ingredients added, moisture content and the like can be varied to suit the particular intended application(s) of the fibre feed products.

Figure 8 illustrates a modified embodiment of Figure 1 where the hot dry flue gas 29 to dry the wet shredded fodder, in the drying plant 12, is provided by the boiler 27 of the sugar cane mill 20 and/or by a separate furnace 27a, located at the feed mill 20, which burns bagasse from the bagasse stockpile 26.

Figure 9 illustrates a further embodiment where the legume fodder crop is converted to hay.

The legume fodder crop is delivered to the feed mill 10 as hereinbefore described.

The crop is fed to rotary knives 11a, where the fibre is cut into shorter pieces (and may be at least partially shredded).

The prepared cut fodder is then dried in the drying plant 12, as hereinbefore described.

The dry processed fodder is conveyed to a baler 13a, where it

may be mixed with molasses to increase the nutritional value of the fodder, before being baled.

The resultant baled hay is transferred to an outloading/containerisation plant 15a for transport to the end users.

Advantages of the preferred embodiments of the present invention include:

A. Basic Process Advantages

1. Immediate post harvest processing minimises loss of nutrients.

2. Maximum cell breakage improves availability and digestibility of nutrients.

3. Drying prevents microbiological degradation of nutrients.

4. Process fits in with sugar mill processes to extend the economic utilisation of capital equipment in sugar mills.

5. Results in more effective use of the energy available in the by-product bagasse enabling more economic value to be added to the fodder crop thereby generating more income for the major stakeholders in the cane sugar industry. This opportunity is not available in the competing beet sugar industry and so presents a sustainable competitive advantage for the cane sugar industry over the beet sugar industry.

6. Raw material crop can be selected to fit in with sugar cane farming systems.

B. Potential Process Modifications

1. The basic process may be improved by extracting the

juice from the freshly shredded material prior to drying the fibrous residue.

2. The juice extracted may be concentrated at a low temperature so as not to damage its nutrient value. This could be done by evaporation under partial vacuum or by a membrane process such as ultrafiltration, nanofiltration or reverse osmosis provided such process did not harm the nutrient value of the juice.

3. The dried material, whether the juice has been extracted or not, may be separated by physical means such as screening and aerodynamic separation techniques into stem material and leaf material.

4. The separated leaf and stem materials, and the concentrated juice may be used to make a range of specially formulated products.

C. <u>Advantages of Potential Process Modifications</u>

1. Leaf material is more digestible and of higher nutritional value than stem material.

2. Leaf, stem and concentrated juice can be recombined in varying proportions from 0% to 100% of any of them and with other ingredients to produce a number of specially formulated feed products.

3. Physical separation processes can also be used to remove mineral particles above a certain particle size.

The inventor has calculated out a typical seasonal scenario to take into account likely seasonal variations in lucerne growth rates and also to maximise the quantity of lucerne able to be processed given a limited quantity of sugar cane.

The implications of this calculation are:

1. The lucerne processing rate needs to vary from 60% to 150% of the average rate;

2. The energy efficiency of the sugar mill process must be maximised (i.e., steam consumption minimised);

3. The generation of hot gas from incineration of bagasse in a separate furnace (not forming part of a boiler) needs to be carried out throughout the year to a greater or lesser extent depending on the lucerne processing rate and the sugar mill process steam demand; and

4. Approximately 20% of the total bagasse produced must be stockpiled for use during the non-crushing season.

The critical advantage is generating substantially more income and profitability for core sugar industry stakeholders i.e., growers and millers, within an integrated farming, processing and logistics system.

Various changes and modifications may be made to the embodiments described and illustrated without departing from the scope of the present invention.

DATED this Fourth day of November 2002.

PETER JOHN JAMES

and

DIANE LAURA JAMES

by their patent Attorneys

FISHER ADAMS KELLY

Synergistic Co-Location of Process Plants
Systems Diagram
Sugar Cane Crushing Season

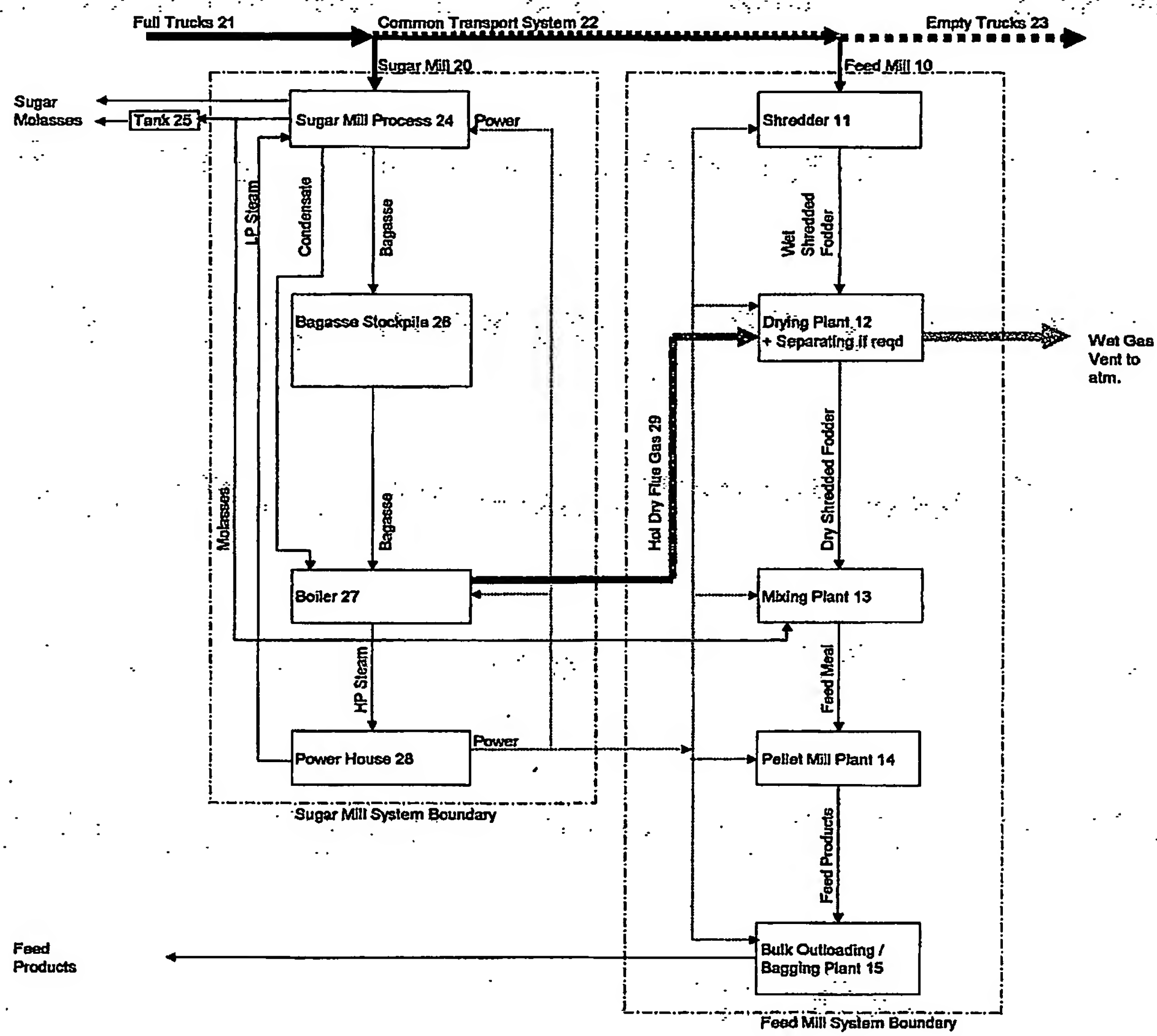

Figure 1

Synergistic Co-Location of Process Plants
Systems Diagram
Sugar Cane Non-Crushing Season

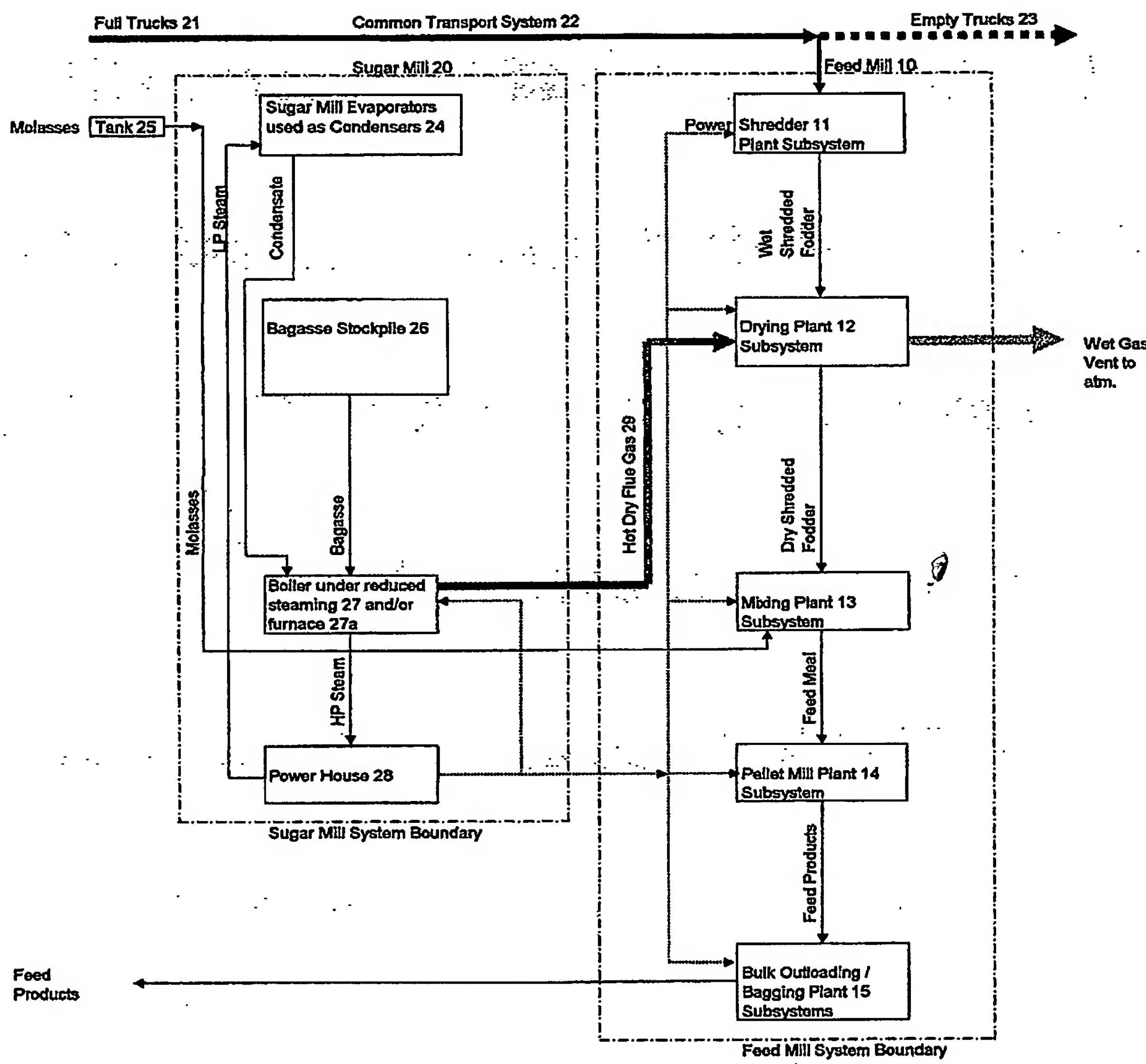

Figure 2

Synergistic Co-Location of Process Plants
Feed Mill System Diagram
Feed Mill Shredder and Optional Juice Extraction and Concentration Plant Subsystems

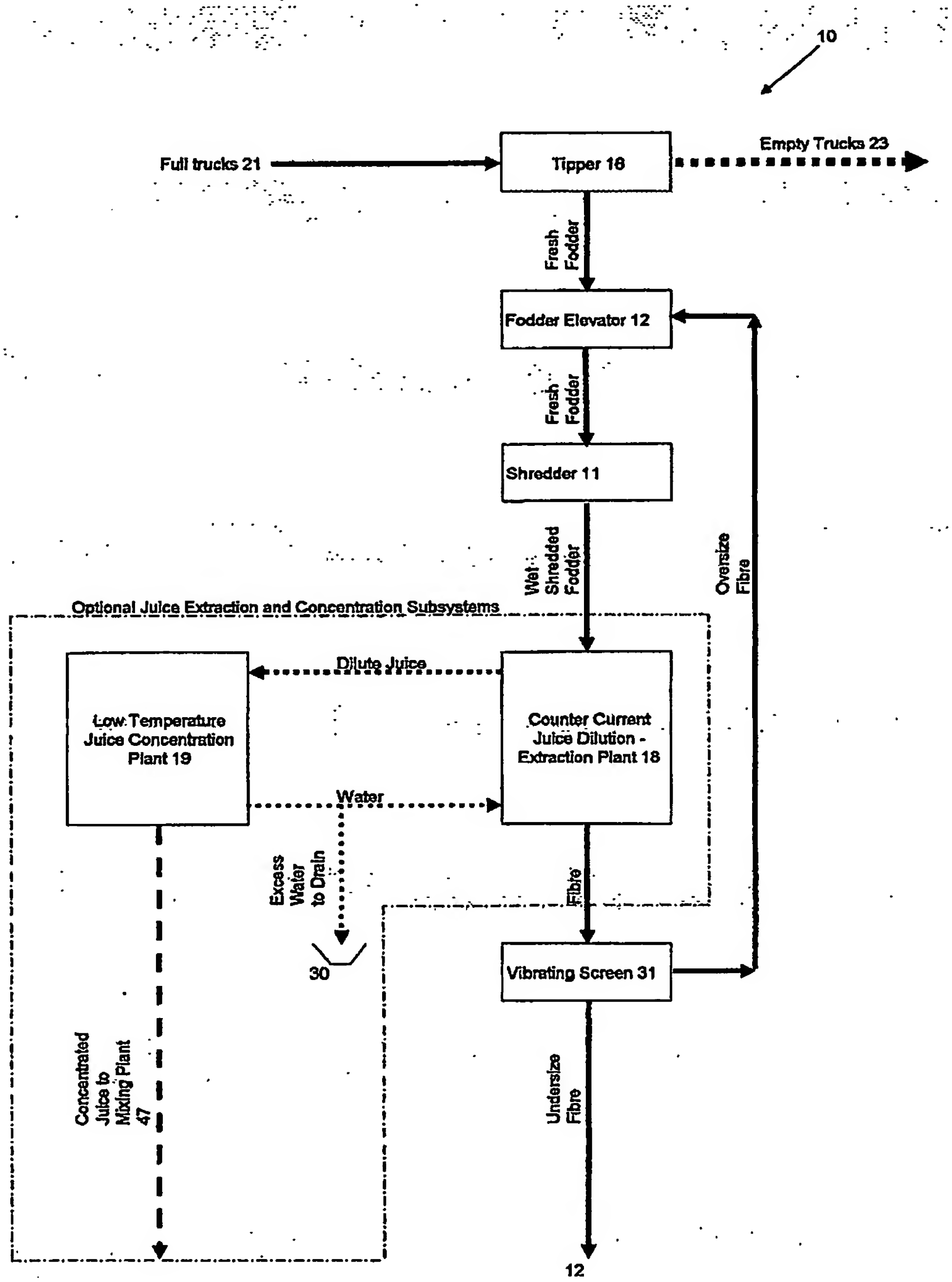

Figure 3

Synergistic Co-Location of Process Plants
Feed Mill System Diagram
Drying Plant and Optional Size Separation and Degritting Plant Subsystems

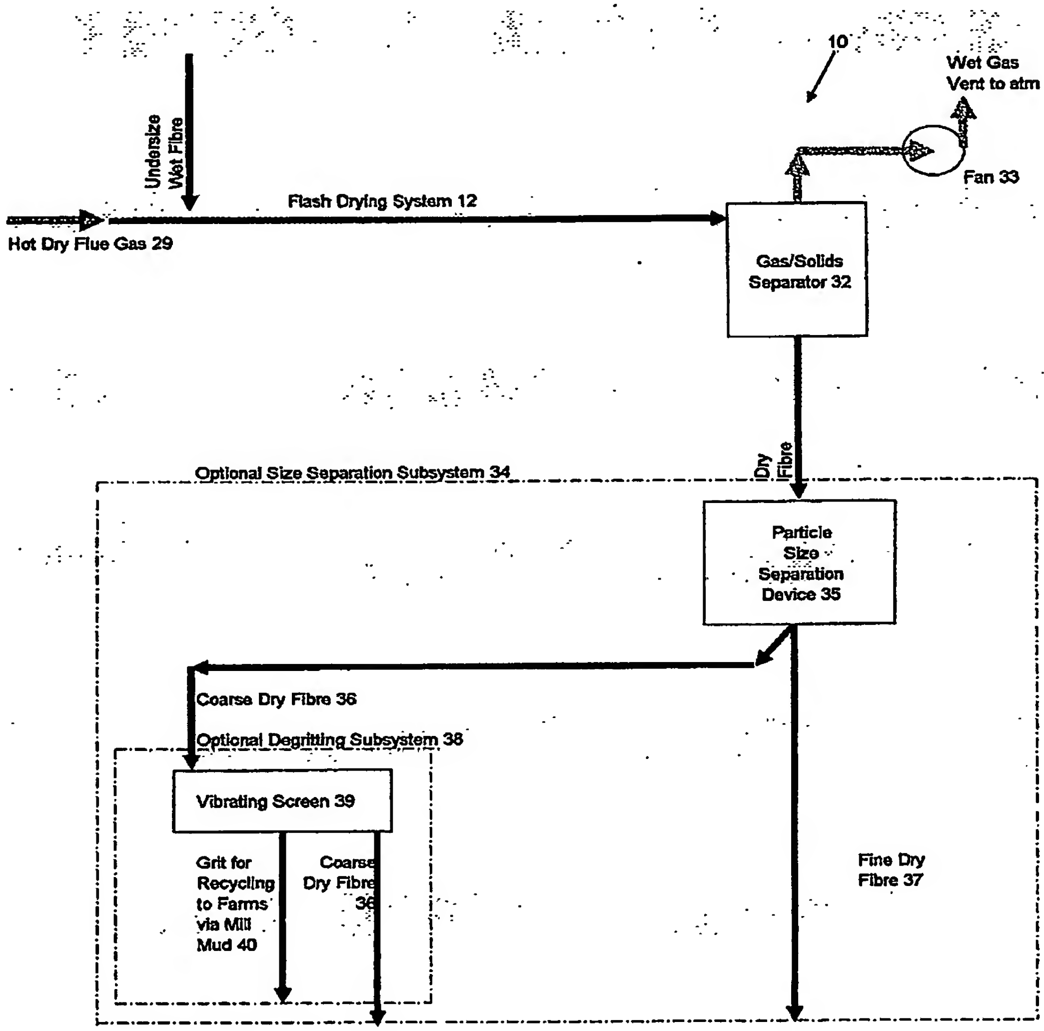

Figure 4

Synergistic Co-Location of Process Plants
Feed Mill System Diagram
Continuous Mixing and Optional Batch Mixing Plant Subsystems

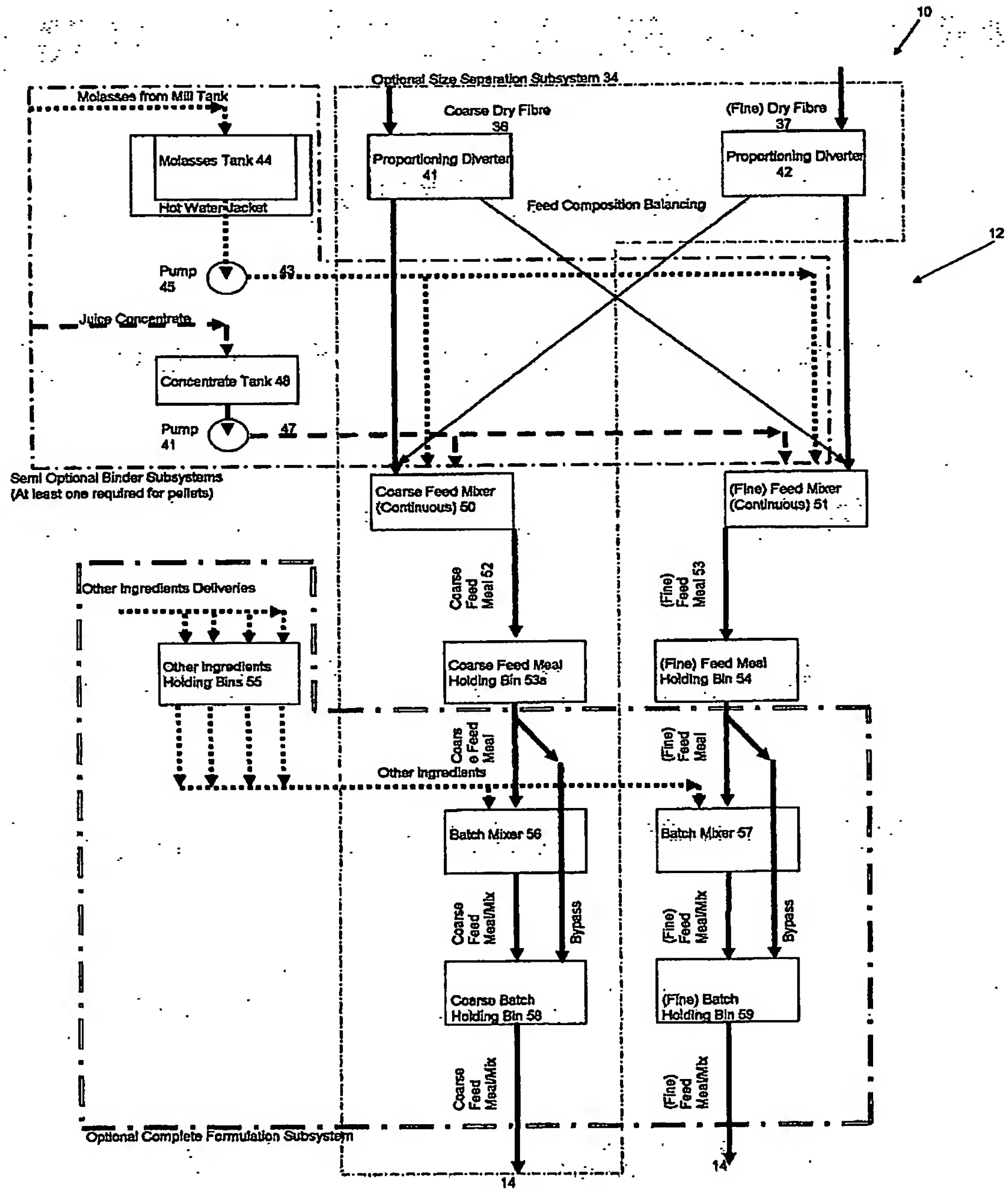

Figure 5

Synergistic Co-Location of Process Plants
Feed Mill System Diagram
Pellet Mill Subsystems

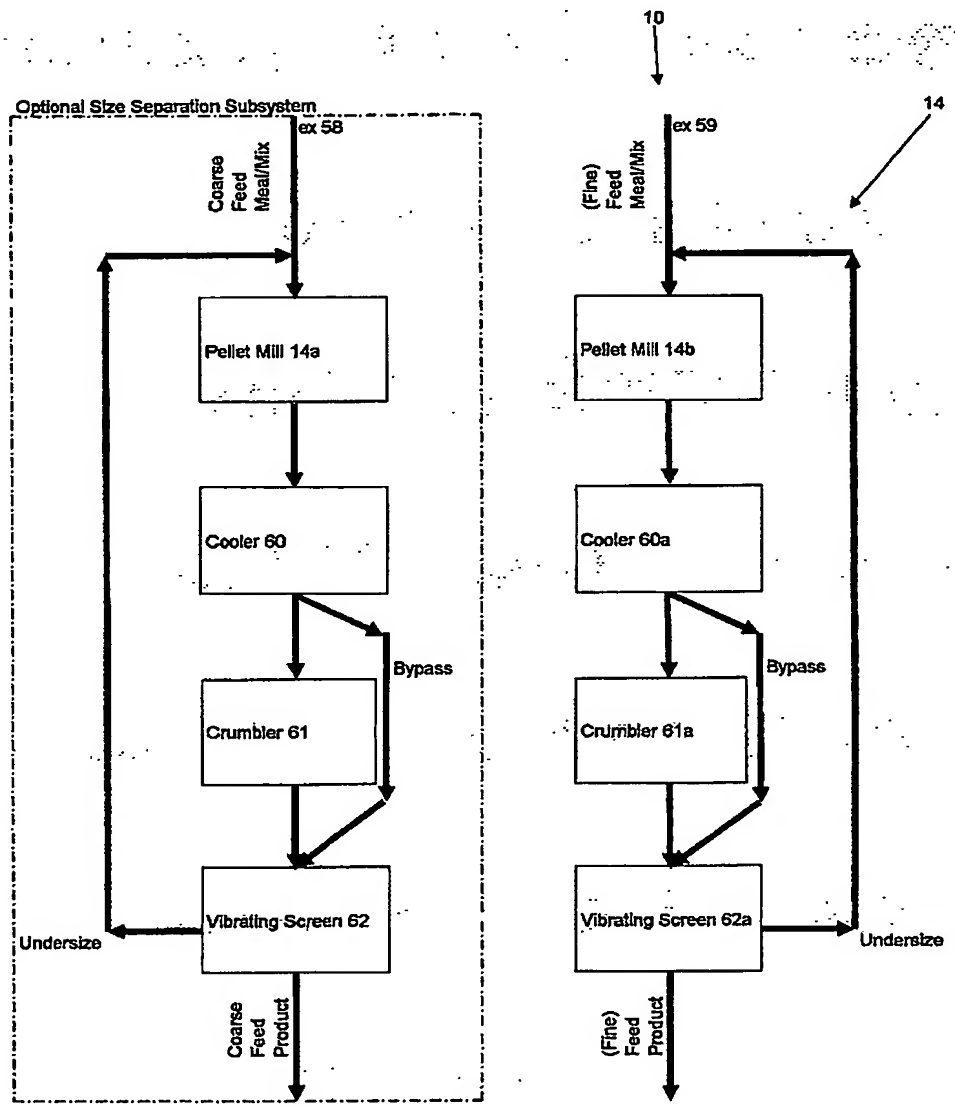

Figure 6

Synergistic Co-Location of Process Plants
Feed Mill System Diagram
Outloading and Bagging Plant Subsystems

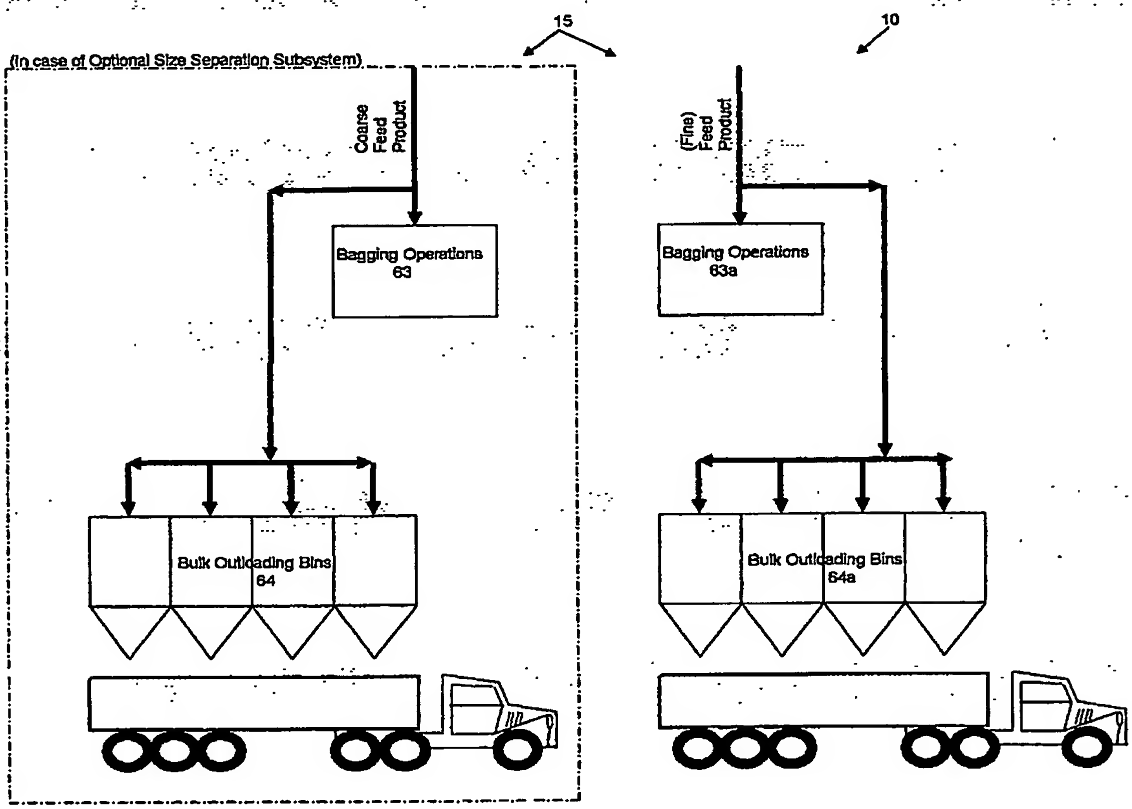

Figure 7

Synergistic Co-Location of Process Plants
Systems Diagram
Basic System with Furnace

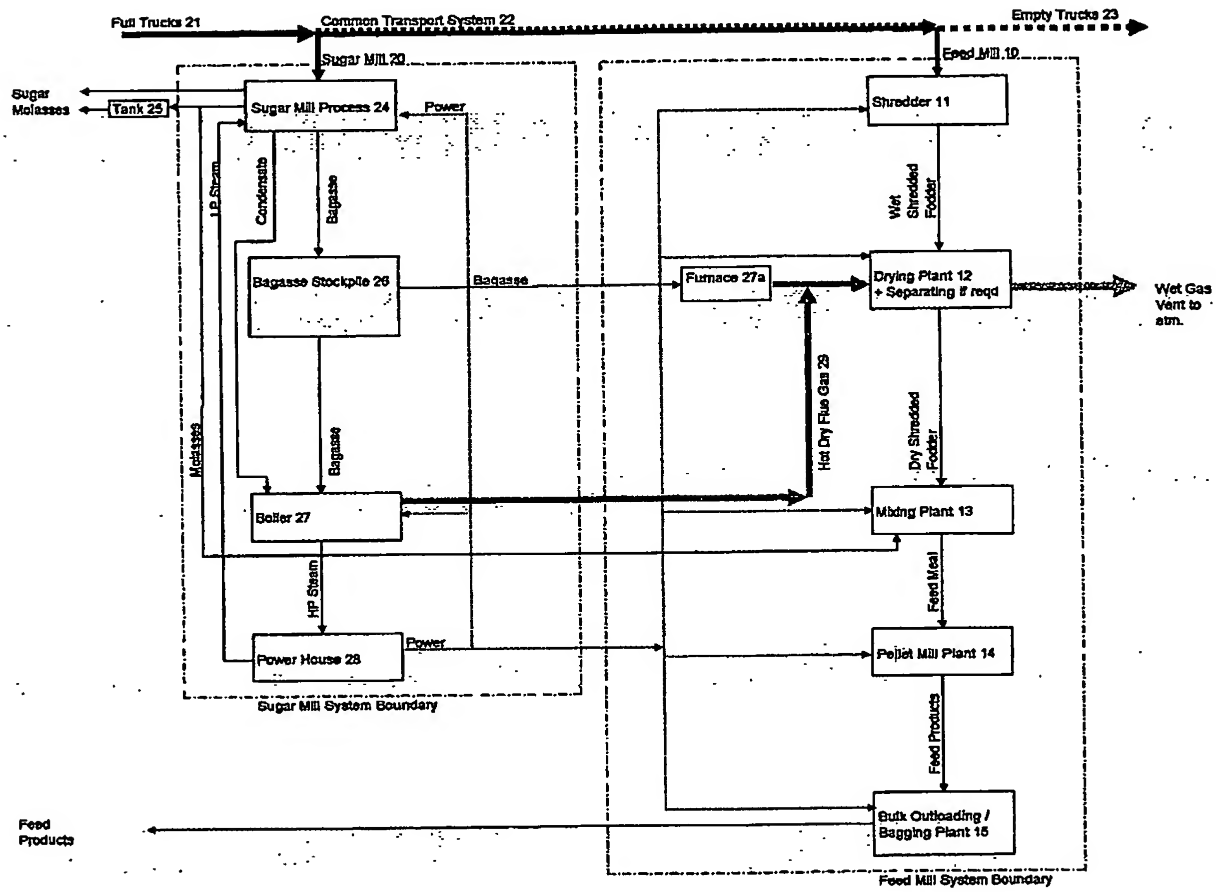

Figure 8

Synergistic Co-Location of Process Plants
Systems Diagram
Basic System for Baled Hay

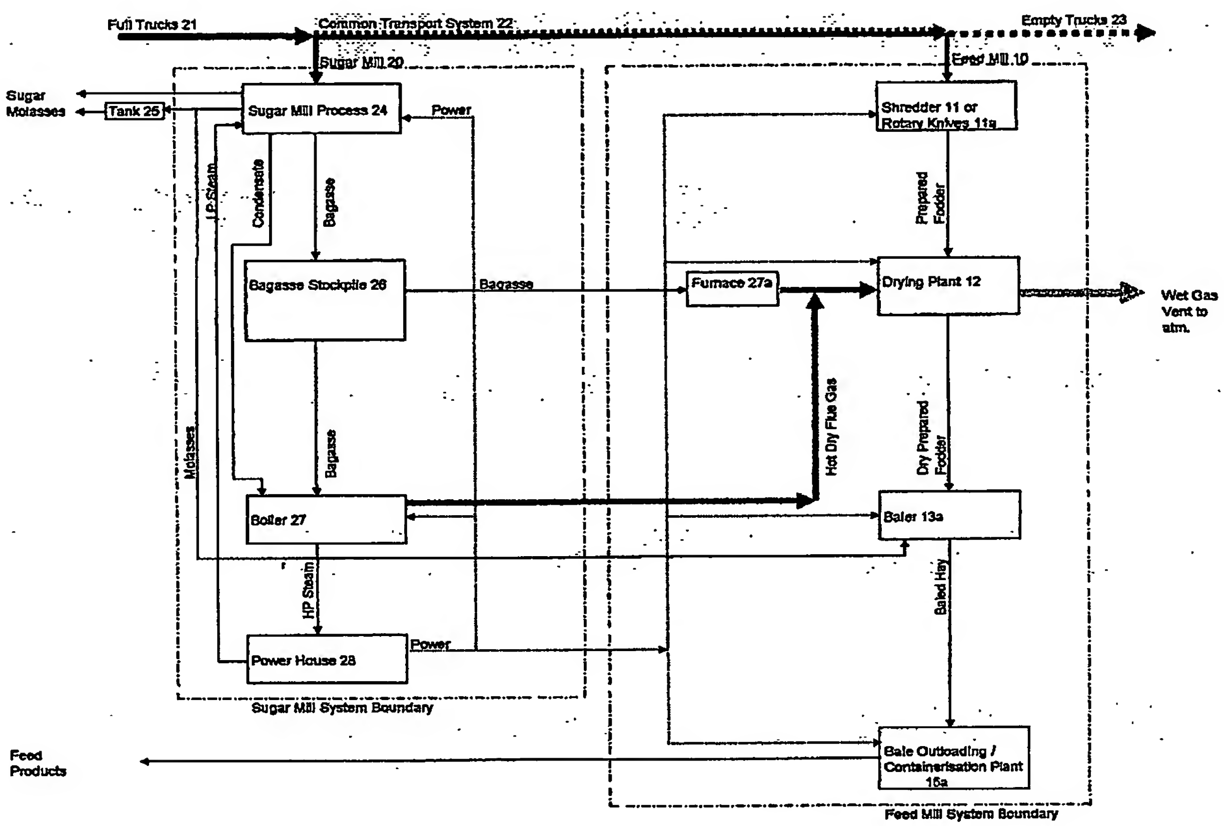

Figure 9